ACTIVITY 12

Migrating Mangroves and Marshes

Estuary Principle

Ongoing research and monitoring is needed to increase our understanding of estuaries and to improve our ability to protect and sustain them.

Research Question

What do research and long-term monitoring reveal about changes in estuary habitats and the animals adapted to live in those habitats?

Introduction

Animals and plants are adapted to survive in a narrow range of habitats. Changes in those habitats affect the animals and plants that live in them.

At Harbor Island, Texas, which is part of the Mission-Aransas National Estuarine Research Reserve (MA NERR), there are mangroves and salt marshes. Both of these habitats occur along the Gulf Coast where the salty, tidal waters flood the salt marshes and mangroves each day. Even though these habitats occur in similar locations, different animals live in them.

Scientists at MA NERR and their colleagues elsewhere have been studying the expansion and contraction of mangrove habitat for many years. They have been trying to determine what causes areas of mangrove habitat to increase (expand) or shrink (contract). In this activity, students will learn about the species that live in salt marsh and mangrove habitats, and will look at data from long-term monitoring in order to understand how these habitats can change over time.

Climate Extension

Using historical data and maps from the Mission-Aransas National Estuarine Research Reserve, students will consider climate change potential impact on mangrove habitats.

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TEACHER GUIDE

Migrating Mangroves and Marshes

Research Question

What do research and long-term monitoring reveal about changes in estuary habitats and the animals adapted to live in those habitats?

Content Objectives

Students will understand that:

- Animals and plants have adaptations that allow them to live and thrive in different estuary habitats, such as salt marshes or mangrove habitats.
- Living things are affected by changes in their habitat.
- Habitats can expand or contract due to outside changes in things that affect either the physical components of the habitat or the organisms that help define the habitat.
- Research on habitats and species ranges, coupled with long-term monitoring, can give clues to why estuary habitats change over time.

Exercises

Exercise 1: What Lives in Mangrove and Salt Marsh Habitats?

In this exercise, students research animals that live in mangroves and salt marshes. Each student completes an Animal Flash Card about one animal. Students are asked to think about how the animals are adapted to live in these two estuary habitats.

Exercise 2: Mapping Mangroves

Students study changes in the mangrove habitat at Harbor Island, located in the Mission-Aransas National Estuarine Research Reserve, between the years of 1930 and 2004. Using historical habitat maps and long term data sets, students will make correlations between air temperature and habitat composition.

Climate Extension

Using long term data sets and the correlated response of mangroves, students will predict how climate change is likely to affect the spread of mangroves and other organisms in the area in the future. Students will consider the value of long-term monitoring in understanding the impacts of climate change.

Assessment Questions

Assessment questions based on content covered in *Migrating Mangroves and Marshes* can be downloaded on the web page for this activity in the Middle School Curriculum section of the Estuary Education website at estuaries.noaa.gov.

Vocabulary

Adaptation – unique feature or behavior that helps an animal or plant survive in its environment.

Habitat – the specific environment where an animal or plant is able to survive.

Mangrove – any of several tree species that grow in non-freezing estuaries. There are about 12 species though the black, red, and white are most common. The word mangrove can also refer to the entire habitat created by the trees, which is sometimes called a mangrove forest or mangrove swamp.

Marsh – a wetland habitat dominated by grasses or grass-like plants. A salt marsh is a marsh that is flooded by salty water, such as water from the ocean.

Monitoring – sampling of environment (air, water, soil, vegetation, animals) that is compared with baseline samples to see if any changes have occurred.

Range – the geographic region in which a plant or animal typically lives or grows.

Research – systematic investigation to establish facts.

Salinity – the amount of dissolved salt content of in a body of water.

Wetland – an area of land that is saturated with water during at least part of the year and which supports plant life.

EXERCISE 1

What Lives in Mangrove and Salt Marsh Habitats?

Estuary Concept

Adaptation is an unique feature or behavior that helps an animal or plant survive in its environment.

Focus Questions

- What animals live in the salt marsh in Texas?
- What animals live in the mangrove habitat in Texas?
- How are animals adapted to survive in these two estuary habitats?

Performance Tasks

Students will:

- Name at least two animals that live in the salt marsh and mangrove habitat.
- Explain how a specific chosen salt marsh or mangrove animal is adapted to survive in that estuary habitat.

Overview

In this exercise, students study animals that live in salt marshes and mangrove habitat along the Gulf Coast of the United States, specifically at the Mission-Aransas National Estuarine Research Reserve (MA NERR) in Texas. Students create flash cards for the animals and are asked to examine how these animals have adaptations that help them live and thrive in a particular estuary habitat.

Time Required

One 45-minute class period

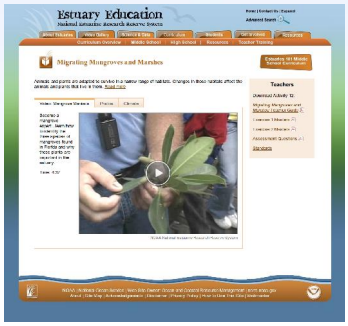
Teacher Background

Salt water estuaries are areas where freshwater rivers meet and mix with ocean waters. The mixture of salt water and freshwater creates a lively, ever-changing, sometimes stressful habitat for plants and animals. As it does in the ocean, the tide rises and falls within the estuary. This creates a zone along the shoreline that is sometimes underwater (at high tide) and sometimes exposed to the air (at low tide). This "intertidal zone" has unique and important habitats, including familiar rocky intertidal (tide pool) areas where sea stars, anemones, and crabs thrive, as well as salt marshes and mangrove habitat. The plants and animals that live in these habitats must be adapted to survive in both water and air. Many of them can survive in water with a range of salinities and extreme temperatures.

Salt marshes throughout the United States are typically covered with tall grasses or rushes, such as cordgrass, needlerush, or bulrush and some smaller plants, such as saltgrass and pickleweed. In the salt marshes at the Mission-Aransas National Estuarine Research Reserve (MA NERR) in Texas, cordgrasses and salt grass are common. The cordgrasses grow close together and can be about three feet tall, while the saltgrass forms dense mats and is much shorter. There are lots of places for small animals, such as crabs, to hide between the stems of the cordgrasses and salt grass. Other animals, such as snails, wander up and down the stems, or dig into the mud below the plants.

Other coastal areas along the warmer parts of the Gulf Coast and east coast of Florida are dominated by mangrove trees. At Harbor Island in the MA NERR, there are black mangroves. Mangroves have many branches that weave together. It is very hard for a person to walk through mangroves. If you tried, you would sink deep into the mud and get tangled in the branches. But that dense, tangled swamp provides a great habitat for many animals.

You'll find multimedia and other resources on the web page for this activity in the Middle School Curriculum section of the Estuary Education website: http://estuaries.noaa.gov.



Both the salt marsh and mangrove habitats provide homes for crabs, snails, fish, and birds. Some species of animals live only in one habitat or the other. Other animals frequent both habitats. In general, these animals have specific adaptations ("survival structures") that help them survive in the salt marsh and/or the mangrove habitat.

Teacher Preparation

Read the Teacher Background above and the Student Master: *What Lives in Mangrove and Salt Marsh Habitats?* Familiarize yourself with the animals featured on the animal flash cards, as well as the flash card template your students will be using.

You will want to provide your students with access to materials (e.g., books, web sites) they can use to research their animals. The materials you provide do not need to be specific to coastal Texas or the Mission-Aransas NERR. Some photos of salt marsh and mangrove animals can be found on the web page for this activity in the Middle School Curriculum section of the Estuary Education website at estuaries.noaa.gov..

Make copies of Student Master: *What Lives in Mangrove and Salt Marsh Habitats?* and Student Master: *Animal Flash Card.*

Procedure

1. Distribute copies of the Student Master: *What Lives in Mangrove and Salt Marsh Habitats?* Have your students read the introduction to salt marshes and mangrove habitats. Ask them to look closely at the pictures of each habitat and imagine what it would be like to live in each habitat.
2. Now distribute copies of Student Master: *Animal Flash Card*. Ask your students to read over the Animal Flash Card template. Let students choose an animal from either of the two animal lists provided on Student Master: *What Lives in Mangrove and Salt Marsh Habitats?* Each student will research an animal and complete an Animal Flash Card for that animal based on their research.
3. Students will need to do research on their animal using books or the Internet.
4. Decide whether or not you want students to present their Animal Flash Cards to the class. This may be a good opportunity for you to highlight the adaptations students have uncovered in their research. For example, your students might easily find these adaptations when researching the salt marsh animals:
    - The snowy egrets' best-known adaptation is their yellow feet, which they jiggle around underwater to attract prey. Like the whooping crane, the snowy egret's long legs and long toes help them wade through the salt marsh and walk on the mud.
    - The marsh wren has excellent camouflage. Their behavior is also an adaptation that helps them avoid predators. They are very secretive and often remain hidden in dense stands of plants so it is difficult for predators to find them.
    - Blue crabs have sharp powerful claws for capturing prey and protecting

Materials

Per student

- Student Master: *What Lives in Mangrove and Salt Marsh Habitats?*
- Student Master: *Animal Flash Card*

themselves from predators. They also have paddle-like back fins for more efficient swimming. That means that, if they can't fight or scare off their predator, they have the option of turning and quickly swimming away.

5. If you want, you can collect and bind students' completed Animal Flash Cards into a book or post them around the classroom. You could also make copies of either the student cards or the suggested answer cards provided here and distribute complete sets to your students.

TEACHER MASTER

Examples of Completed Flash Cards

Common name of animal: Gulf Marsh Fiddler Crab

Formal (Latin) name of animal: *Uca longisignalis*

Lives in which habitat? Salt marsh

1. **What does the animal eat?**

   Detritus

2. **Does the animal find its food in the salt marsh or in the mangrove habitat? If neither, where does the animal find its food?**

   Salt marsh (mud)

3. **List one or more adaptations that help the animal find or eat food.**

   Small claw, specialized mouth parts sort biotic material from abiotic. Non-edible components are shaped into ball and discarded.

4. **What are the animal's predators?**

   Whooping cranes, snowy egrets, other birds, and raccoons.

5. **List one or more adaptations that help the animal avoid predators.**

   Camouflage, retreat into burrows

6. **Does the animal nest or have its young in the salt marsh or in the mangrove habitat? Where does it have its young?**

   In salt marsh. Females carry eggs then release them into the water where they join the plankton.

7. **List one or more adaptations the animal has that help it find a mate or protect its young.**

   Males have one larger claw that it used to attract females.

Common name of animal: Gulf killifish

Formal (Latin) name of animal: *Fundulus grandis*

Lives in which habitat? Salt marsh, lagoons, rivers

1. **What does the animal eat?**

   The killifish is omnivorous, It eats algae, vascular plants, grass shrimp, copepods, mosquito larvae and pupae, bivalve mollusks, and small fishes.

2. **Does the animal find its food in the salt marsh or in the mangrove habitat? If neither, where does the animal find its food?**

   In salt marsh, in shallow water.

3. **List one or more adaptations that help the animal find or eat food.**

   Wide range of acceptable foods.

4. **What are the animal's predators?**

   Snowy egret, whooping crane, herons, blue crabs, larger fish

5. **List one or more adaptations that help the animal avoid predators.**

   Camouflage and the ability to stay in very shallow water to avoid larger aquatic predators

6. **Does the animal nest or have its young in the salt marsh or in the mangrove habitat? Where does it have its young?**

   In salt marsh. Female deposits eggs in shallow water in densely vegetated areas (the marsh).

7. **List one or more adaptations the animal has that help it find a mate or protect its young.**

   Males are brilliantly colored during mating season to attract females.

Common name of animal: Whooping Crane

Formal (Latin) name of animal: *Grus americana*

Lives in which habitat? Salt marsh

1. **What does the animal eat?**

   In their Texas wintering grounds, they feed on crustaceans, mollusks, fish, berries, small reptiles, and aquatic plants. When they are in the northern breeding areas in the summer, they eat frogs, mice and voles, smaller birds, fish, aquatic insects, clams, crayfish, snails, and berries.

2. **Does the animal find its food in the salt marsh or in the mangrove habitat? If neither, where does the animal find its food?**

   In wintering grounds, they feed in the salt marsh or in shallow water.

3. **List one or more adaptations that help the animal find or eat food.**

   Sharp beak, quick lunge for capturing prey, long legs and unwebbed feet for wading through the water

4. **What are the animal's predators?**

   Large mammals (like bobcats) or birds (like eagles or ravens) may prey on eggs or young.

5. **List one or more adaptations that help the animal avoid predators.**

   Adults are large enough that they are rarely preyed upon. Young are camouflaged and adults defend nests and young.

6. **Does the animal nest or have its young in the salt marsh or in the mangrove habitat? Where does it have its young?**

   Birds nest in freshwater wetlands in Canada and northern United States.

7. **List one or more adaptations the animal has that help it find a mate or protect its young.**

   Whooping cranes have a dramatic courting 'dance' that involves head bobbing, wing flapping, jumping, and calling. They also have a bald patch on their heads that becomes more colorful in mating season.

Common name of animal: Snowy Egret

Formal (Latin) name of animal: *Egretta thula*

Lives in which habitat? Salt marsh and mangrove habitat

1. **What does the animal eat?**

   Small fish, crabs, shrimp, insects, amphibians, or reptiles

2. **Does the animal find its food in the salt marsh or in the mangrove habitat? If neither, where does the animal find its food?**

   Snowy egrets hunt in the marsh or in the mangrove habitat, often in tidal channels or shallow water.

3. **List one or more adaptations that help the animal find or eat food.**

   Quick beak for capturing prey. Snowy egrets have yellow feet which may be used to attract prey. They can be seen wiggling their feet underwater while hunting.

4. **What are the animal's predators?**

   Nest and juvenile predators, but adults are rarely preyed upon. Humans used to shoot them for their feathers (plumage).

5. **List one or more adaptations that help the animal avoid predators.**

   They nest high in trees in large colonies.

6. **Does the animal nest or have its young in the salt marsh or in the mangrove habitat? Where does it have its young?**

   No, they nest in colonies in trees, sometimes quite distant from their feeding grounds.

7. **List one or more adaptations the animal has that help it find a mate or protect its young.**

   During breeding season the adults have beautiful, flowing feathers (or plumes) that they display during courting.

Common name of animal: Marsh Periwinkle Snail

Formal (Latin) name of animal: *Littorina irrorata*

Lives in which habitat? Salt m**arsh**

1. **What does the animal eat?**

   The marsh periwinkle snail is herbivorous. It grazes on algae, fungi, and marsh cordgrass.

2. **Does the animal find its food in the salt marsh or in the mangrove habitat? If neither, where does the animal find its food?**

   In salt marsh

3. **List one or more adaptations that help the animal find or eat food.**

   Food is plentiful. Snails may actually "farm", or encourage the growth of, fungus on marsh grass stems.

4. **What are the animal's predators?**

   Blue crabs, large fish, large birds, raccoons

5. **List one or more adaptations that help the animal avoid predators.**

   They have very hard shells and can pull themselves entirely inside the shell.

6. **Does the animal nest or have its young in the salt marsh or in the mangrove habitat? Where does it have its young?**

   In salt marsh.

7. **List one or more adaptations the animal has that help it find a mate or protect its young.**

   Unknown

Common name of animal: Blue crab

Formal (Latin) name of animal: *Callinectes sapidus*

Lives in which habitat? Salt marsh

1. **What does the animal eat?**

   A wide variety of food, but especially mollusks including oysters and mussels

2. **Does the animal find its food in the salt marsh or in the mangrove habitat? If neither, where does the animal find its food?**

   Salt marsh and more open water areas

3. **List one or more adaptations that help the animal find or eat food.**

   Blue crabs have strong claws that allow them to capture and consume prey.

4. **What are the animal's predators?**

   Fish and other blue crabs

5. **List one or more adaptations that help the animal avoid predators.**

   Camouflage, strong sharp claws, aggressive behavior, paddle-like back fins for more efficient swimming to get away fast

6. **Does the animal nest or have its young in the salt marsh or in the mangrove habitat? Where does it have its young?**

   Blue crabs may mate in shallow water in the salt marsh or in seagrass beds, but they release their planktonic young into the coastal ocean waters.

7. **List one or more adaptations the animal has that help it find a mate or protect its young.**

   Adult females mate only one time when they shed their exoskeletonsduring their last molt. Prior to this molt, they release chemicals that attract males. A male protects the female and mates with her during the molt. Spawning is timed very precisely seasonally and with the tide so that the planktonic young are carried into the coastal ocean.

Common name of animal: Marsh wren

Formal (Latin) name of animal: *Cistothorus palustri*

Lives in which habitat? Salt marsh

1. **What does the animal eat?**

   Spiders and insects, including aquatic insects

2. **Does the animal find its food in the salt marsh or in the mangrove habitat? If neither, where does the animal find its food?**

   In salt marsh

3. **List one or more adaptations that help the animal find or eat food.**

   Beak for catching insects

4. **What are the animal's predators?**

   Nest predators, including mammals and birds (crows, ravens, jays)

5. **List one or more adaptations that help the animal avoid predators.**

   Excellent camouflage, secretive behavior, hides easily in dense vegetation

6. **Does the animal nest or have its young in the salt marsh or in the mangrove habitat? Where does it have its young?**

   In salt marsh

7. **List one or more adaptations the animal has that help it find a mate or protect its young.**

   Marsh wrens may build "dummy" nests, which may act as decoys so predators are less likely to find their real nests. Some wrens also use these nests as winter shelters. Males sing to protect/announce territory during mating.

Common name of animal: Roseate Spoonbill

Formal (Latin) name of animal: *Ajaja ajaja*

Lives in which habitat? Mangrove habitat

1. **What does the animal eat?**

   Small fish, crustaceans, amphibians, reptiles, and aquatic insects

2. **Does the animal find its food in the salt marsh or in the mangrove habitat? If neither, where does the animal find its food?**

   In mangrove habitat and shallow water

3. **List one or more adaptations that help the animal find or eat food.**

   May feed in groups. Wide, sensitive bill is moved through water to encounter and capture prey. Long legs, unwebbed feet for wading through the water.

4. **What are the animal's predators?**

   Nest predators include mammals (raccoons and coyotes) and birds (turkey vultures and crows).

5. **List one or more adaptations that help the animal avoid predators.**

   Unknown

6. **Does the animal nest or have its young in the salt marsh or in the mangrove habitat? Where does it have its young?**

   Nest in mangrove habitat

7. **List one or more adaptations the animal has that help it find a mate or protect its young.**

   Nest in trees in colonies. Male and female both sit on nest.

Common name of animal: Periwinkle snail

Formal (Latin) name of animal: *Littoraria angulifer*

Lives in which habitat? Mangrove habitat

1. **What does the animal eat?**

   The snail is herbivorous.

2. **Does the animal find its food in the salt marsh or in the mangrove habitat? If neither, where does the animal find its food?**

   In mangrove habitat

3. **List one or more adaptations that help the animal find or eat food.**

   Food is plentiful.

4. **What are the animal's predators?**

   Large fish, birds, mammals

5. **List one or more adaptations that help the animal avoid predators.**

   They have very hard shells and are able to pull themselves entirely inside.

6. **Does the animal nest or have its young in the salt marsh or in the mangrove habitat? Where does it have its young?**

   In salt marsh

7. **List one or more adaptations the animal has that help it find a mate or protect its young.**

   Unknown

Common name of animal: Mangrove tree crab

Formal (Latin) name of animal: *Aratus pisonii*

Lives in which habitat? Mangrove habitat

1. **What does the animal eat?**

   Mangrove tree crabs mostly eat plant material, including mangrove leaves, but will also consume animals or parts of animals that they encounter (i.e. crab legs, fish scales, etc.).

2. **Does the animal find its food in the salt marsh or in the mangrove habitat? If neither, where does the animal find its food?**

   In the mangrove habitat

3. **List one or more adaptations that help the animal find or eat food.**

   Unknown

4. **What are the animal's predators?**

   Adults are preyed upon by birds, mammals, and larger crabs.

5. **List one or more adaptations that help the animal avoid predators.**

   Camoflage, actively climb and cling to branches, move rapidly, can jump from branches to mud or water.

6. **Does the animal nest or have its young in the salt marsh or in the mangrove habitat? Where does it have its young?**

   Females carry eggs in spongy mass on abdomen and release them into the water as plankton.

7. **List one or more adaptations the animal has that help it find a mate or protect its young.**

   Males defend territories. Adult females mate only one time, during their last molt (when they shed their exoskeletons). Reproduction occurs year-round.

Common name of animal: Mangrove rivulus fish

Formal (Latin) name of animal: *Rivulus marmoratu*

Lives in which habitat? Mangrove habitat, salt marsh

1. **What does the animal eat?**

   Insects, worms, gastropods, mollusks

2. **Does the animal find its food in the salt marsh or in the mangrove habitat? If neither, where does the animal find its food?**

3. **List one or more adaptations that help the animal find or eat food.**

   The mangrove rivulus fish can survive out of water for a long time, so it can flop its way from one isolated puddle to another in search of water and food.

4. **What are the animal's predators?**

   Wood storks, other fish including other mangrove rivulus, and the Atlantic saltmarsh snake

5. **List one or more adaptations that help the animal avoid predators.**

   The mangrove rivulus fish varies in color, either lighter or darker, depending on the sediment it is near.

6. **Does the animal nest or have its young in the salt marsh or in the mangrove habitat? Where does it have its young?**

   The mangrove rivulus fish releases its eggs in the mangrove habitat where the water is less likely to dry up than isolated puddles in the salt marsh.

7. **List one or more adaptations the animal has that help it find a mate or protect its young.**

   The mangrove rivulus fish produces both eggs and sperm, so it can fertilize its own eggs. It does not need a mate.

STUDENT MASTER

What Lives in Mangrove and Salt Marsh Habitats?

Polar bear in native Arctic habitat

Black mangrove

Salt marsh

Are you likely to find a polar bear hunting for seals in the warm coastal waters off of Hawaii? No! What if someone brought a polar bear to Hawaii? Could it survive in the wild? No! Animals are adapted to survive in specific habitats. A polar bear is adapted to survive in the cold Arctic, so it has immensely warm fur. The white fur camouflages the bear, allowing it to blend in with the ice. And the bear's powerful legs are great for running and swimming from ice floe to ice floe. Those adaptations help the polar bear survive in the Arctic. However, all that warm, white fur would probably prevent a polar bear from surviving in Hawaii.

At Harbor Island, Texas, which is part of the Mission-Aransas National Estuarine Research Reserve (MA NERR), there are mangroves and salt marsh habitats. Both of these habitats occur along the Gulf Coast where the salty, tidal waters flood the salt marsh and mangrove habitat each day. Even though these habitats occur in similar locations, different animals live in them. A marsh is a wetland habitat dominated by grasses or grass-like plants. A salt marsh is a marsh that is flooded by salty water, such as water from the ocean. Mangrove habitat consists of saltwater wetlands that are dominated by trees, such as the black mangrove. Some animals are adapted to survive in the salt marsh while others live only in mangrove habitat.

In this exercise, you will choose a specific salt marsh or mangrove animal to study. You need to learn why that animal lives in the salt marsh or the mangrove habitat and how the animal is adapted to survive in that habitat.

Procedure

1. Read the introduction above. Then look closely at the photos of the two habitats: the mangrove and the salt marsh habitats. Imagine what it would be like to be an animal living in each habitat.
2. Choose a salt marsh or mangrove animal to study from the lists on the next page.
3. Use references provided by your teacher to fill out an Animal Flash Card for your animal.

Selected Animals of the Mangrove

Common name	Formal (Latin) name	Common name	Formal (Latin) name
Periwinkle snail	*Littoraria angulifer*	Mangrove tree crab	*Aratus pisonii*
Mangrove rivulus fish	*Rivulus marmoratu*	Roseate spoonbill	*Ajaia ajaja*
Snowy egret	*Egretta thula*		

Selected Animals of the Salt Marsh

Common name	Formal (Latin) name	Common name	Formal (Latin) name
Fiddler crab	*Uca longisignalis*	Gulf killifish	*Fundulus grandis*
Whooping crane	*Grus americana*	Snowy egret	*Egretta thula*
Marsh periwinkle snail	*Littorina irrorata*	Blue crab	*Callinectes sapidus*
Marsh wren	*Cistothorus palustri*		

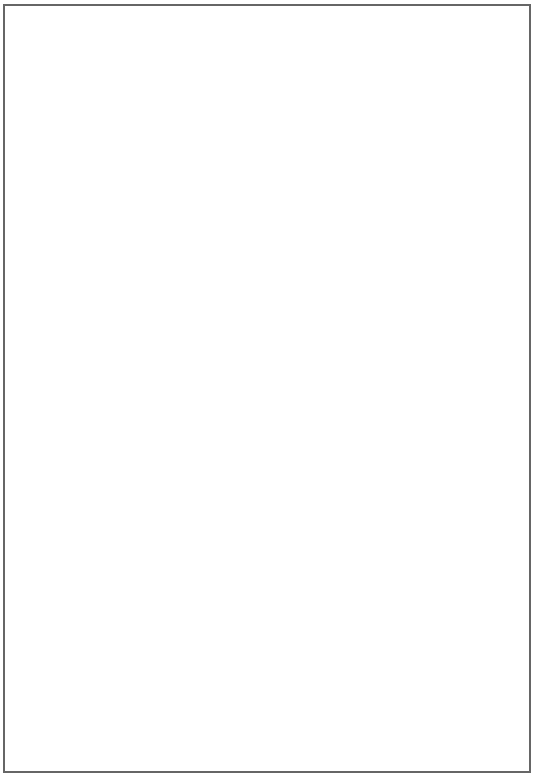
STUDENT MASTER

Animal Flash Card

Common name of animal: _____

Formal (Latin) name of animal: _____

Lives in which habitat? _____



Draw your animal or print out a photograph and place it here.

1. What does the animal eat?

2. Does the animal find its food in the salt marsh or in the mangrove habitat? If neither, where does the animal find its food?

3. List one or more adaptations that help the animal find or eat food.

4. What are the animal's predators?

5. List one or more adaptations that help the animal avoid predators.

6. Does the animal nest or have its young in the salt marsh or in the mangrove habitat? Where does it have its young?

7. List one or more adaptations the animal has that help it find a mate or protect its young.

EXERCISE 2

Mapping Mangroves

Estuary Concept

Research on habitats and species ranges, coupled with long-term monitoring, can give clues to why estuary habitats change over time.

Focus Questions

- What causes the mangrove habitat at Harbor Island to expand or contract over time?
- What might happen to mangrove habitat as Earth's climate changes?

Performance Tasks

Students will:

- Interpret maps showing the range of mangrove habitat and salt marshes in the Harbor Island area over several decades.
- Correlate severe winter weather events with mangrove habitat contraction.
- Predict likely response of mangroves to climate change.

Teacher Background

Scientists at the Mission-Aransas National Estuarine Research Reserve (MA NERR) in Texas and their colleagues elsewhere have been studying the expansion and contraction of mangrove habitat for many years. They have been trying to determine what causes mangrove ranges to increase (expand) or shrink (contract). Research has shown that the range of black mangroves is limited by winter temperatures. Mangroves cannot survive long periods of freezing temperatures. The real extent of mangrove habitat expands during times when the winter weather is warmer and contracts after winters when temperatures drop below freezing for extended periods of time. For example, in December of 1983 the temperature in the MA NERR dropped below freezing for several straight days. Black mangrove trees were severely damaged by this freeze and the overall area covered by mangroves contracted. Severe freeze events in December 1989 contributed to mangrove range contraction in the 1980s. Because of their sensitivity to weather, black mangroves may be a good indicator species for climate change. Some scientists think that, in recent years, the area of mangroves is expanding as increasing temperature causes a northern shift in the distribution of both black and red mangroves.

Climate Extension

One of the reasons National Estuarine Research Reserves have been established is to ensure there are protected estuaries around the United States set aside for long-term monitoring and research. Monitoring is the continuous scientific study of an environmental variable with the goal of detecting changes over time. Long-term monitoring programs is critical for understanding climate change since

Overview

In this exercise, students will use four maps that show the extent of mangrove habitat on an island in Texas over a 70-year period. Additional information about the severity of winter weather in the area will be used to study a real estuarine research question: "What is the relationship between mangrove range expansion and contraction and winter air temperatures?"

Students will be studying and interpreting maps and research from the MA NERR in Texas in this exercise. Exercise 2 builds on Exercise 1: *What Lives in Mangrove and Salt Marsh Habitats?* Exercises 1 and 2 can be used independently.

Time Required

One 45-minute class period

For resources and links related to this Climate Extension, look for the Climate tab on the web page for this activity in the Middle School Curriculum section of the Estuary Education website: http://estuaries.noaa.gov.

climate is the average of weather conditions over long periods of time. Monitoring can provide important information on changes that occur slowly; on ecological processes that vary from year to year and can only be understood from a long-term view; and allow us to put into context short-term studies. In this activity, students learn warming temperatures in estuaries associated with climate change are likely causing changes in species range as well as well as habitat composition in Texas estuaries.

Teacher Preparation

Read the introduction of the Student Master: *Mapping Mangroves*. Then read the Teacher Background above.

Make copies of Student Master: *Mapping Mangroves* (including blank map of Harbor Island, four maps of mangrove habitat coverage in different years, and the winter severity bar chart) for each student or student pair.

The four Harbor Island maps can also be put on transparencies and placed one on top of the other to measure change over time.

To save paper, you may choose to do the exercise as a whole-class activity. Consider showing the entire class the maps and filling out the table together, but then providing students or student pairs with the winter severity bar chart and allowing students to find the correlation between severe weather and mangrove habitat contraction.

Procedure

1. Have students learn about black mangroves and mangrove habitat by reading the introduction to this activity. Students need to have knowledge about adaptations and environmental tolerances of black mangroves.
2. Students will first study the four mangrove range maps for the Harbor Island area. The maps can be used to see changes in the area covered by mangroves over time. Using this information, students will fill out the appropriate columns of the data table on the Student Master.
3. Based on the data table and the maps, students will answer the first question, in which they are asked to guess why the mangrove range expanded and contracted when it did. Remind students of the mangrove's tolerances for salinity, temperature, and water depth.
4. Next, students will look at a bar chart showing freezing events at Harbor Island from 1950 through 2004. You may want to examine this chart with your students and make sure that they are interpreting it correctly. There are two different sets of data being displayed for each winter. The first set shows the maximum number of consecutive days when the minimum air temperature fell below freezing. Remember, mangroves do not tolerate freezing. However, at Harbor Island during the winter, it can be freezing at night and then quite warm the next day. That isn't so bad for the mangrove. The second set of data shows the number of consecutive days when the maximum air temperature was also below freezing. Not every winter has this second set of data but, where that data exists, it means that temperatures were below freezing, both night and day, for several days straight. It is that sort of "hard" freezing event that can harm the mangroves and cause the mangrove

Materials

Per student or student pair

- Copy of Student Master: *Mapping Mangroves* (including blank map of Harbor Island, four maps of mangrove coverage in different years, and winter severity bar chart)
- Markers/colored pencils

habitat to contract.

5. Students are then asked to read the explanation on the Student Master and answer the remaining Climate Extension questions. Possible responses to all of the questions are shown below.

Questions and Possible Answers

During the time period…	Did the mangrove range expand or contract?
1930 to 1979	Expand
1979 to 1995	Contract
1995 to 2004	Expand

Q1. Based on what you have learned about the black mangrove's tolerances and adaptations, what do you think could have caused the habitat to contract or expand?

Student answers are based on the table which, in turn, is based on the four maps. Students should suggest that something happened between 1979 and 1995 to cause the mangrove habitat to contract during that period. The student has been presented with three different factors that might negatively affect the mangrove: low temperature, increased water depth, or decreased salinity. Without data, students may suspect any of those three things. A major flood event could have lowered water salinity in the area. The maps do not seem to suggest increased water depth during this time period (although there is some suggestion that water depth did increase between 1995 and 2004). As is explained later, low temperatures associated with a harsh winter in late 1983 were in fact the cause of mangrove contraction.

Q2. If you could look at historical records of the mangrove ranges at Harbor Island, when else would you expect there to have been post-freeze contraction in the mangrove habitat area?

Students should see that there were also significant freezing events in the winters of 1950-1951 and 1961-1962. If you could see records of health of the mangroves after those winters, or see maps showing mangrove habitat area for times after those winters, you might expect to find that mangroves were damaged by the freeze events in those two winters and that mangrove habitat probably contracted to some extent after those two winters.

Climate Extension

Q3. Earth's climate is changing. In Texas, scientists expect increasingly warmer weather, with fewer days of freezing temperatures. Based on the patterns of change you saw in the earlier maps, use the colored pencils and the blank map of the Harbor Island area to show what you think the mangrove area in Harbor Island might look like in 2030. Remember to put a color key somewhere on your map (i.e., what color did you use to show mangrove habitat?).

Students should understand that a warmer climate means fewer and fewer hard winters for the Harbor Island area. This means that the mangroves will not experience the freeze-related damage. The mangrove range is expected to

continue to expand in the future. Therefore, student maps should show a larger area of Harbor Island covered by mangroves in 2030 than is shown in the map for 2004.

Q4. What happens to animals that live in a habitat when that habitat expands? What happens when that habitat contracts or disappears?

If a habitat such as the mangrove expands, there is more area in which animals adapted to that habitat can live. Usually, they will increase their population to take advantage of the new habitat area. However, if the habitat contracts, the populations of animals adapted to that habitat will decrease. Animals may leave the area to find other locations with that habitat. If that isn't possible, the animals will likely face increased competition in the remaining habitat's area and their populations may decrease. Generally, animal populations will increase or decrease in response to changes in the animals' habitats; the animals cannot adapt to new or changing habitats as quickly as the habitats can change.

Q5. In the study of climate change impacts, why is it important to conduct collect data over many years through long term research and monitoring projects?

Students could have a variety of answers that include some of the following points. Climate change is the shift in the average of weather conditions over long periods of time, therefore researchers inherently need to develop long term monitoring projects to collect data on environmental changes that may be occurring slowly. The size of the mangrove habitat on Harbor Island varied dramatically over the 70 years, if the research project was shorter it would have only captured a snapshot of the mangrove habitat, instead of the dramatic increases and decreases seen over time. In the case of the mangrove study they needed many years of data to confirm that it was temperature, not other environmental variables like salinity that were causing the impacts to the mangrove habitat.

STUDENT MASTER

Mapping Mangroves

The black mangroves on Harbor Island, Texas are growing at the northern limit of their range. They can't survive any farther north because they are not adapted to the freezing temperatures that occur more frequently there. When the temperature drops below freezing, individual black mangrove trees may be damaged or killed. The longer the temperature remains below freezing, the more damage there is to the trees.

The black mangrove's range is also limited by water salinity and water depth. The mangroves grow in brackish or salty water, not in fresh water. They also cannot grow in water that is too deep because they need to get air to their roots. Temperature, salinity, and water depth all determine where the black mangroves can and cannot grow.

On Harbor Island, the percent of the land covered by mangroves changes over time. Sometimes, over a period of one to many years, the mangrove habitat expands. Other times, mangrove trees die and the area of the island covered by mangroves contract.

In this exercise, you will look at maps showing areas of Harbor Island covered by mangroves at four times (1930, 1979, 1995, and 2004). You will then examine information about prolonged freezing weather events in the Harbor Island area. From these data, you can answer the research question: "Is mangrove expansion and contraction correlated to changes in air temperature?" You will also follow-up with a hypothesis about future changes in mangrove habitat coverage on the island.

Procedure

1. Read the introduction to learn about the environmental conditions needed for black mangrove survival.
2. You have four maps of Harbor Island, each showing the extent of mangrove habitat in different years. First, compare the map from 1930 to the one from 1979. According to the maps, did the area covered by mangrove habitat expand or contract from 1930 to 1979? If it expanded, write "Expand" in the appropriate box in the data table. If the area contracted, write "Contract".
3. Now compare the maps from 1979 and 1995. What happened to the area covered by mangroves from 1979 to 1995? Did it expand or contract? Write your observation in the data table.
4. Lastly, compare the maps from 1995 and 2004. Write your observation in the data table.

Data Table

During the time period…	Did the mangrove range expand or contract?
1930 to 1979	
1979 to 1995	
1995 to 2004	

5. To look for possible explanations as to why the mangrove habitat may have contracted between 1979 and 1995, scientists examined the maximum and minimum air temperatures during that period, particularly for the winter months. To get an idea of what they found, examine the Winter Severity bar chart.

Additional Information

Scientists found that the temperature dropped well below freezing around Harbor Island for several days in the winter of 1983-1984. Although there are days when the average temperature was below freezing during other years, the "big freeze" in December 1983 was much more severe, with more consecutive days of freezing temperatures and no daytime "thaws." Scientists believe that the extended period of cold weather in December of 1983 caused individual

mangrove trees to be damaged or killed, and therefore caused the overall contraction of the mangrove habitat observed after 1979. Further damage was done by a smaller freeze event in the winter of 1989-1990. You can see both of these freeze events on the Winter Severity bar chart.

Questions

Q1. Based on what you have learned about the black mangrove's tolerances and adaptations, what do you think could have caused the habitat to contract or expand?

Q2. If you could look at additional historical records of the mangrove habitat at Harbor Island, when else would you expect there to have been post-freeze contraction in the mangrove habitat area?

Climate Extension

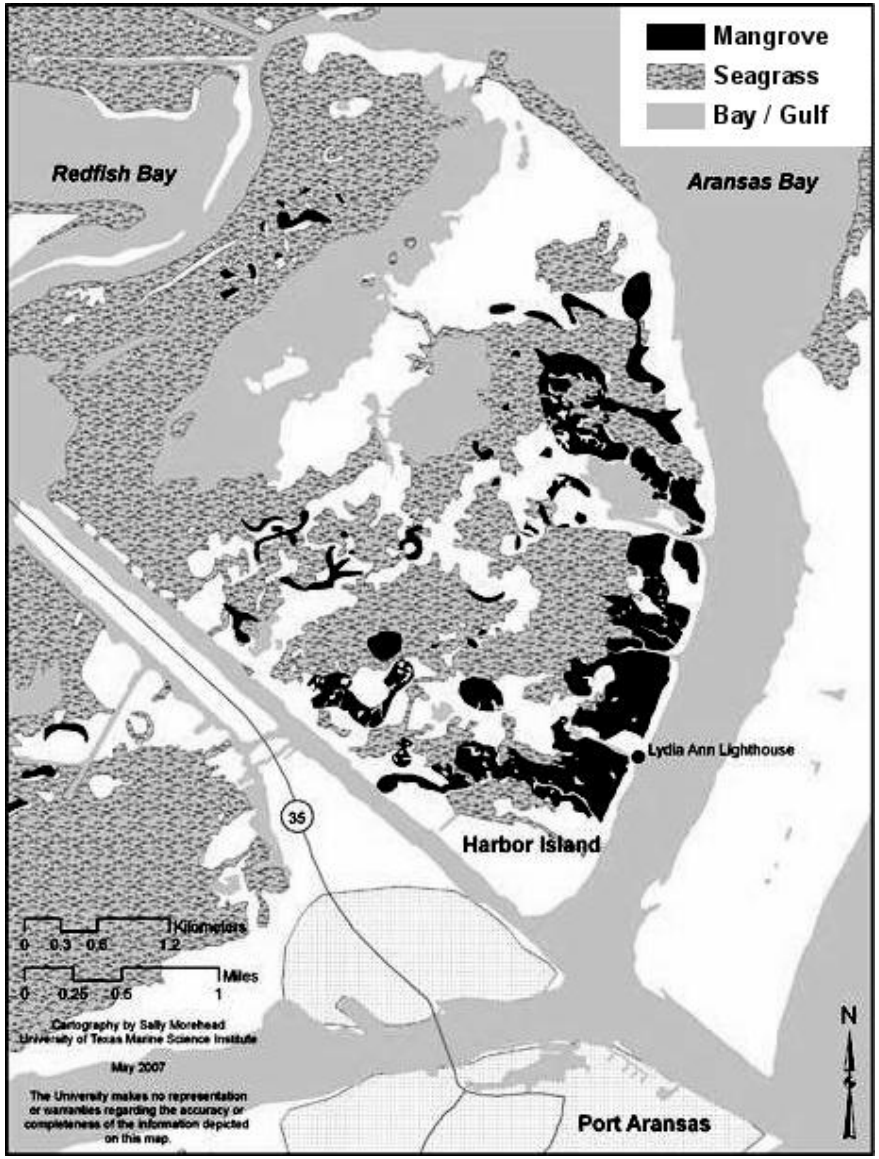
Q3. Earth's climate is changing. In Texas, scientists expect increasingly warmer weather, with fewer days of freezing temperatures. Based on the patterns of change you saw in the earlier maps, use the colored pencils and the blank map of the Harbor Island area to show what you think the mangrove area in Harbor Island might look like in 2030. Remember to put a color key somewhere on your map (i.e., show what color you used to show mangrove habitat).

Q4. What happens to animals that live in a habitat when that habitat expands? What happens when that habitat contracts or disappears?

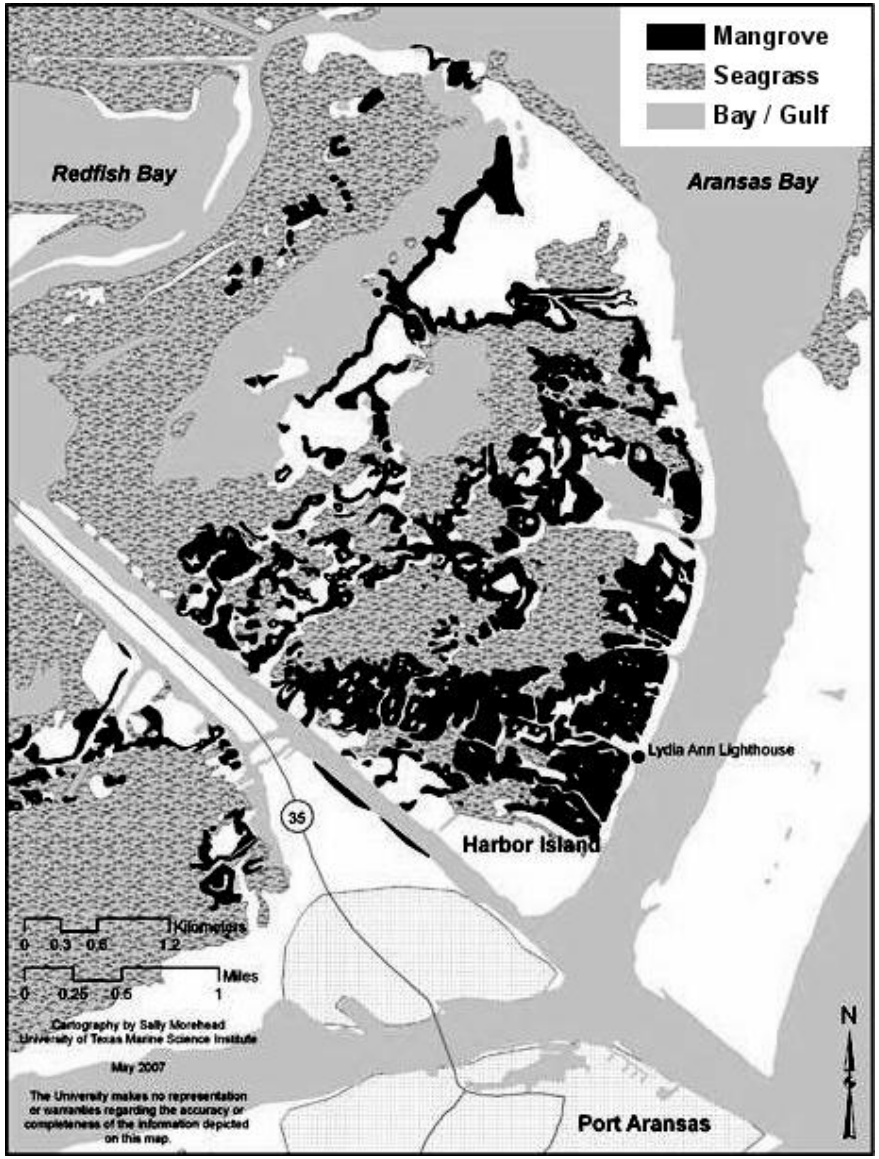
Q5. In the study of climate change impacts, why is it important to conduct collect data over many years through long term research and monitoring projects?

STUDENT MASTER

Harbor Island Mangroves, 1930

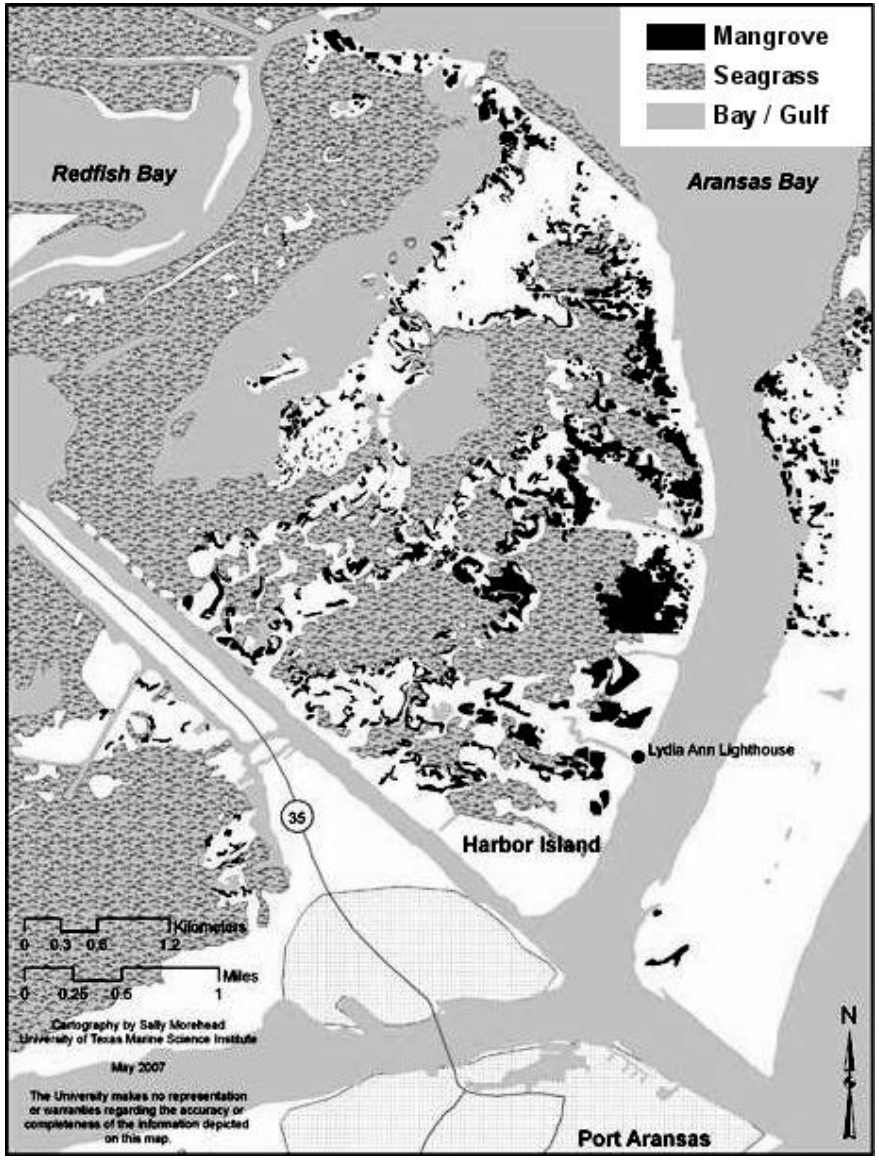


Harbor Island Mangroves, 1979

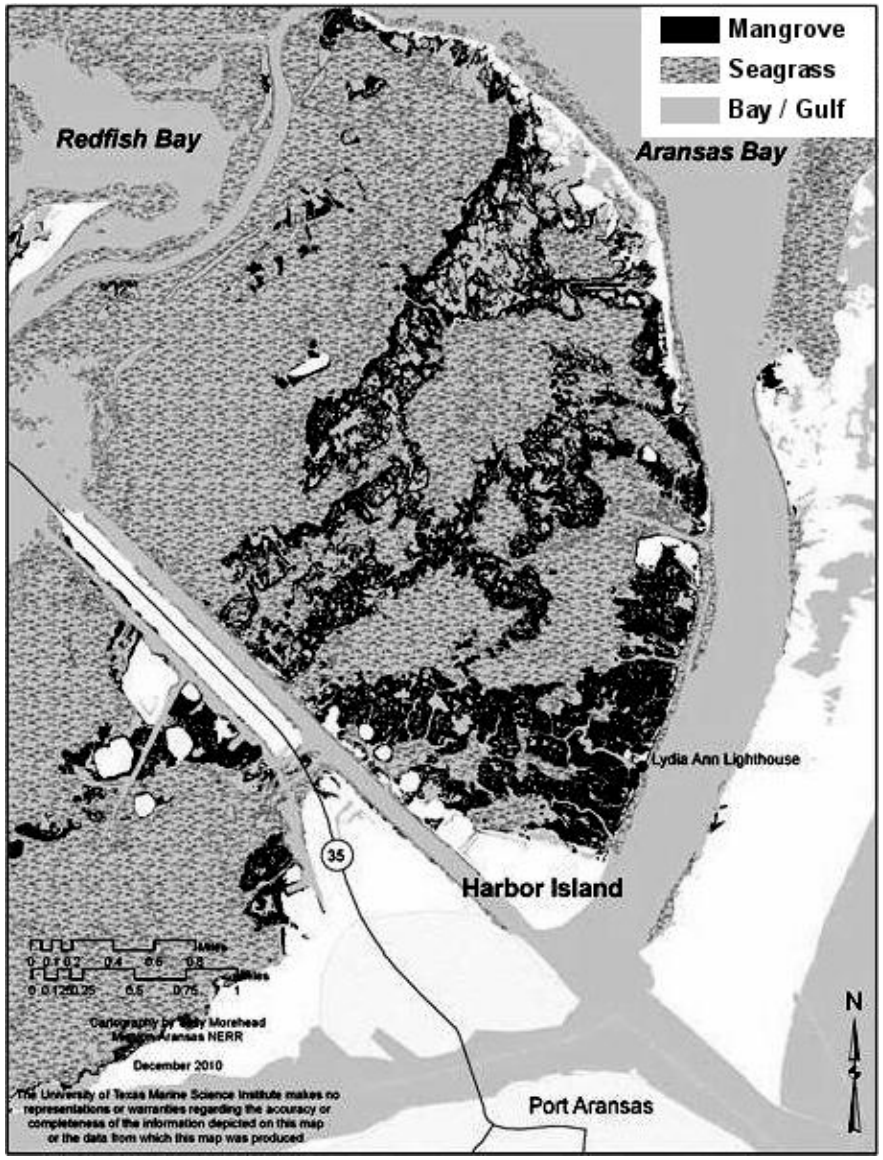


STUDENT MASTER

Harbor Island Mangroves, 1995

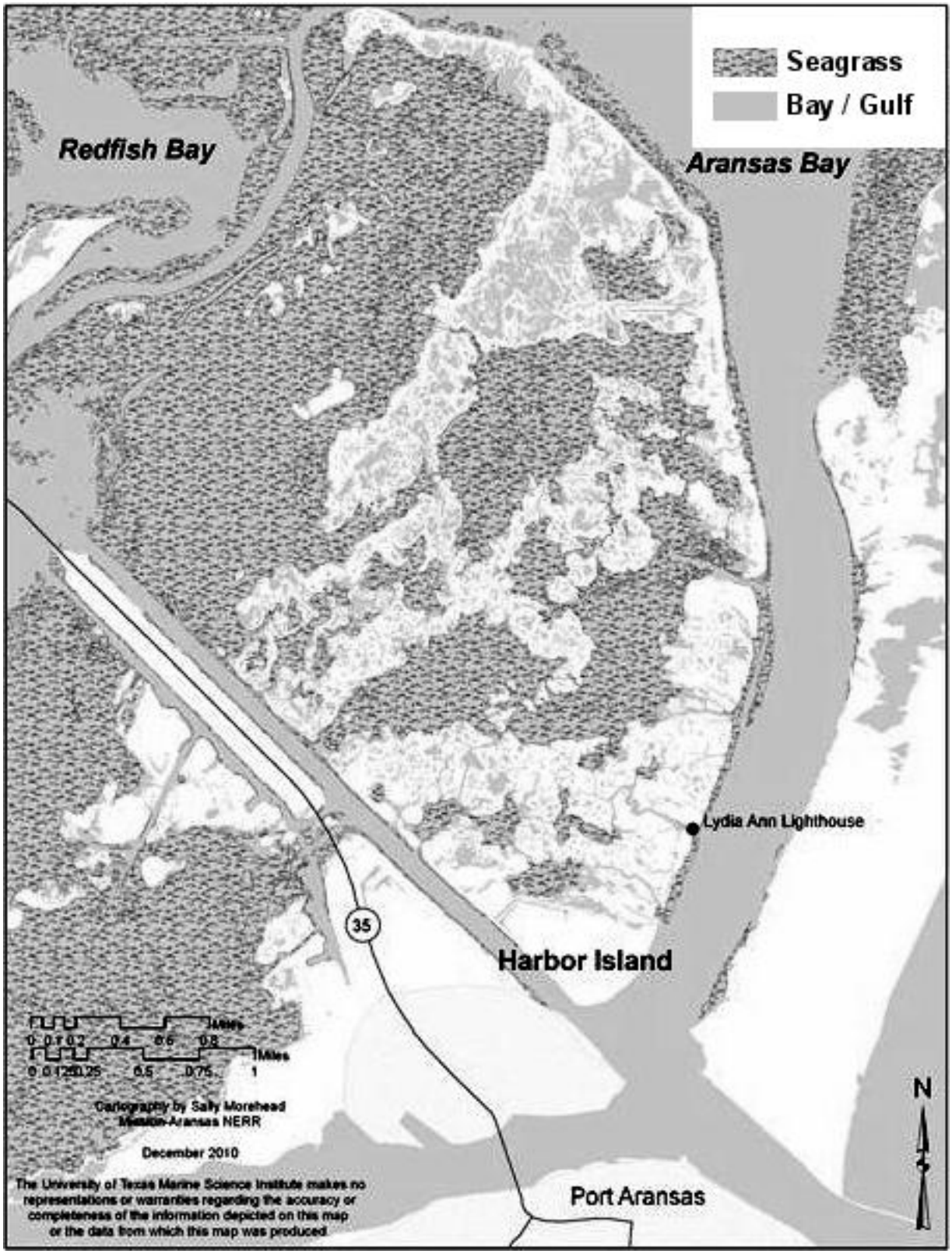


Harbor Island Mangroves, 2004



STUDENT MASTER

Blank Map of Harbor Island



Winter Severity, 1950 to 2004, Harbor Island